

TITLE

**CABLE MODEM THAT CAN PREVENT MODEM SIGNAL FROM
TRANSFERRING TO AN HFC NETWORK WHEN INTERNAL CIRCUIT
OF THE CABLE MODEM OPERATES ABNORMALLY**

CLAIM OF PRIORITY

[0001] This application makes reference to, incorporates the same herein, and claims all benefits accruing under 35 U.S.C. §119 from an application entitled "*CABLE MODEM THAT CAN PREVENT MODEM SIGNAL FROM TRANSFERRING TO THE HFC NETWORK WHEN INTERNAL CIRCUIT OF THE CABLE MODEM OPERATES ABNORMALLY*" earlier filed in the Korean Intellectual Property Office on 15 February 2003 and thereby duly assigned Serial No. 2003-9645.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a cable modem, and more particularly to a cable modem that can prevent a modem signal from transferring to an HFC (Hybrid Fiber Coaxial Network) when an internal circuit of the cable modem operates abnormally.

Description of the Related Art

1 **[0003]** An HFC network using a cable modem is a shared media network, meaning that if an
2 unwanted signal comes from a cable mode connected to a network, or if the cable modem operates
3 abnormally and thus, generates a signal with a particular frequency, the entire system is fatally
4 influenced and in the worst case, the network is likely to be shut down. A related art cable modem
5 controls the transferring of a burst signal to the HFC network, by using an enable signal of a PGC
6 (Programmable Gain Controller) that adjusts or controls signal intensity of the cable modem.

7 **[0004]** A burst signal is used for an up-stream signal of the cable modem to reduce the influence
8 of an unwanted signal on the HFC network using the shared media. The enable signal of the PGC
9 is used to turn on and turn off the burst signal. Therefore, if there is any type of error in the enable
10 signal EN1, an unwanted burst signal of the cable modem flows in the HFC network, causing the
11 entire network to be shut down.

12 **SUMMARY OF THE INVENTION**

13 **[0005]** Accordingly, one object of the present invention is to solve the foregoing problems by
14 providing a cable modem that prevents the entire network from being shut down because of an
15 unwanted modem signal transferred to the HFC network when an internal circuit operates
16 abnormally.

17 **[0006]** It is another object to provide a cable modem of the present invention that can be
18 advantageously used for preventing an up-stream signal of the cable modem from transferring to the
19 HFC network.

20 **[0007]** It is yet another object to provide an efficient manner of preventing an entire network to

1 be shut down when an internal circuit operates abnormally and yet be easy and inexpensive to
2 implement.

3 **[0008]** The foregoing and other objects and advantages are realized by providing a cable modem,
4 which includes: a CPU (Central Processing Unit) for controlling the entire cable modem, generating
5 a first enable signal and a second enable signal, and outputting a data to a data bus; a PGC, under
6 the control of the first enable signal, for receiving a modem signal, adjusting gain, and generating
7 a modem signal with adjusted intensity; a transformer for receiving an output signal from the PGC
8 and isolating the PGC from a next stage; a low pass filter for receiving an output signal from the
9 transformer and filtering off a high-frequency element; and a selecting circuit for receiving the first
10 and second enable signals and an output signal from the low pass filter, and under the control of the
11 first and second enable signals, selectively transferring the output signal from the low pass filter to
12 a network.

13 **[0009]** In the exemplary embodiment of the present invention, the selecting circuit includes: an
14 EX-NOR (exclusive NOR) circuit for receiving the first and second enable signals and performing
15 an exclusive NOR operation; and a switching circuit for receiving an output signal of the EX-NOR
16 circuit and the output signal of the low pass filter, and under the control of the output signal of the
17 EX-NOR circuit, selectively transferring the output signal of the low pass filter to the network.

18 **[0010]** In the exemplary embodiment of the present invention, the switching circuit includes: an
19 NPN transistor having a base terminal to which the output signal from the EX-NOR circuit is
20 applied, and an emitter terminal connected to a ground; a resistor, of which one end being connected
21 to the ground; and a relay having a first terminal connected to a collector terminal of the NPN-type

1 transistor, a second terminal connected to the resistor, a third terminal connected to a supply voltage,
2 a fourth terminal to which the output terminal of the low pass filter is applied, and a fifth terminal
3 to which an output terminal of the switching circuit is connected.

4 [0011] Preferably, the resistance of the switching circuit is 75 Ω (ohms), in consideration of
5 impedance matching.

6 BRIEF DESCRIPTION OF THE DRAWINGS

7 [0012] A more complete appreciation of the invention, and many of the attendant advantages
8 thereof, will be readily apparent as the same becomes better understood by reference to the following
9 detailed description when considered in conjunction with the accompanying drawings in which like
10 reference symbols indicate the same or similar components, wherein:

11 [0013] FIG. 1 schematically illustrates a transmission section of a cable modem of the related art;

12 [0014] FIG. 2 schematically illustrates a transmission section of a cable modem according to an
13 exemplary embodiment of the present invention;

14 [0015] FIG. 3 is a detailed diagram of a selecting circuit of the cable modem in FIG. 2;

15 [0016] FIG. 4 is a detailed diagram of a switching circuit of the selecting circuit in FIG. 3;

16 [0017] FIG. 5 is a detailed diagram of a switching circuit of the selecting circuit in FIG. 3 with an
17 NMOS transistor; and

18 [0018] FIG. 6 is an alternative detailed diagram of the selecting circuit of the cable modem in FIG.

19 2.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0019] Turning now to the drawings, FIG. 1 schematically illustrates a transmission section in a cable modem of the related art. The related art cable modem controls the transferring of a burst signal to the HFC network, by using an enable signal EN1 of PGC (Programmable Gain Controller) 120 that adjusts or controls signal intensity of the cable modem.

[0020] A burst signal is used for an up-stream signal of the cable modem to reduce the influence of an unwanted signal on the HFC network using the shared media. As shown in FIG. 1, the enable signal EN1 of PGC is used to turn on and turn off the burst signal. Therefore, if there is any type of error in the enable signal EN1, an unwanted burst signal of the cable modem flows in the HFC network, causing the entire network to be shut down.

[0021] Reference will now be made in detail to exemplary embodiments of the present invention, which are illustrated in the accompanying drawings.

[0022] FIG. 2 illustrates a transmission section of a cable modem according to an exemplary embodiment of the present invention. The cable modem includes a CPU (central processing unit) 210 for controlling the cable modem 200, generating a first enable signal EN1 and a second enable signal EN2, and outputting a data (DATA) to a data bus, a PGC 220 for receiving an up-stream data and adjusting gain, under the control of the first enable signal EN1, a transformer 230 for receiving an output signal PGCO from the PGC (Programmable Gain Controller) and isolating the PGC 220 from a next stage, a low pass filter 240 for receiving an output signal (TRO) of the transformer 230 and filtering off a high-frequency element, a selecting circuit 260 for receiving the first and second enable signals EN1 and EN2 and an output signal (LPFO) of the low pass filter 240, and under the

control of the first and second enable signals EN1 and EN2, selectively transferring the output signal LPFO of the low pass filter to the next stage, and a tuner 250 for receiving an output signal SCO of the selection circuit and transferring the signal to an HFC network.

[0023] The operation of the transmission section of the cable modem in FIG. 2 is now described.

[0024] The cable modem transfers an up-stream signal to the CMTS (Cable Modem Termination System) through the HFC network, and receives a down-stream signal. In particular, the transmission section of the cable modem in FIG. 2 transfers up-stream signals to the CMTS through the HFC network. Intensity of the up-stream signal, namely data, is adjusted by the PGC 200 under the control of the first enable signal EN1. In general, intensity of signal transmitted from the cable modem 200 to the CMTS is not uniform but variable, depending on the CMTS command. This is because the intensity of an up-stream signal should be increased proportionally to the distance between the cable modem and the CMTS. The transformer 230 isolates the PGC 220 from the low pass filter 240. The up-stream signal intensity is adjusted in the PGC 220, and high-frequency elements in the signal are filtered off by the low pass filter 240. Because signals with frequencies in 5-42 MHz (megahertz) band only are appropriate for the up-stream signal, the low pass filter 240 filters off signals having frequencies greater than 42 MHz. The selecting circuit 260, under the control of the first and second enable signals EN1 and EN2, decides whether or not to transfer the output signal LPFO of the low pass filter to the tuner 250. Depending on the status of two enable signals (EN1 and EN2), the output signal LPFO of the low pass filter is applied to an output terminal T2 of the selecting circuit 260, or the output terminal T2 floats. The output signal SCO of the selecting circuit is loaded on the HFC network through the tuner 250.

[0025] In short, the selecting circuit 260 mounted in the cable modem plays a key role for preventing the up-stream signal from transferring to the HFC network when the internal circuit, particularly the PGC 220, operates abnormally.

[0026] FIG. 3 is a detailed diagram of a selecting circuit of the cable modem in FIG. 2. The selecting circuit 260 in FIG. 2 consists of an EX-NOR (exclusive NOR) circuit EXNOR1 for receiving the first and second enable signals EN1 and EN2 and for performing an exclusive NOR operation, and a switching circuit 262 for receiving the output signal BCS of the EX-NOR circuit EXNOR1 and the output signal LPFO of the low pass filter, and under the control of the output signal BCS of the EX-NOR circuit EXNOR1, outputting the output signal LPFO of the low pass filter 240 in FIG. 1.

[0027] The operation of the selecting circuit 260 of the cable modem in FIG. 3 is now explained.

[0028] When both first enable signal EN1 and second enable signal EN2 are in a “high” or “low” state, the output signal BCS of the EX-NOR circuit EXNOR1 puts in a high state, and the output signal LPFO of the low pass filter is output as an output signal SCO of the selecting circuit. On the other hand, if only one of the first enable signal EN1 and the second enable signal EN2 is in a “high” or “low” state, the output signal BCS of the EX-NOR circuit EXNOR1 puts in a low state, and the output signal LPFO of the low pass filter is not output as an output signal SCO of the selecting circuit. At this time, the output terminal T2 of the selection circuit 260 floats.

[0029] FIG. 4 is a detailed diagram of a switching circuit of the selecting circuit in FIG. 3. The switching circuit in FIG. 4 includes an NPN transistor Q1 having a base terminal (B) to which the output signal BCS of the EX-NOR circuit EXNOR1 in FIG. 3 is applied, and an emitter terminal (E)

connected to a ground, a resistor R1 of which one end being connected to the ground, and a relay having a first terminal (term-1) connected to a collector terminal (C) of the NPN transistor Q1, a second terminal (term-2) connected to the resistor R1, a third terminal (term-3) connected to a supply voltage Vcc, a fourth terminal (term-4) into which the output signal LPFO of the low pass filter 240 in FIG. 2 is input, and a fifth terminal (term-5) from which the output signal SCO of the switching circuit 262 is output.

[0030] The operation of the switching circuit 262 in FIG. 4 is now discussed in the following.

[0031] If the output signal BCS of the EX-NOR circuit EXNOR1 in FIG. 3 is in a “high” state, the NPN transistor Q1 is turned on, and the RELAY connects an output terminal T1 of the low pass filter 240 in FIG. 2 to an input terminal T2 of the tuner 250 in FIG. 2. At this point, the output signal LPFO of the low pass filter 240 in FIG. 2 is output as the output signal SCO of the selecting circuit. Meanwhile, if the output signal BCS of the EX-NOR circuit EXNOR1 in FIG. 3 is in a “low” state, the NPN transistor Q1 is turned off, and the relay connects the output terminal T1 of the low pass filter 240 in FIG. 2 to the resistor R1. At this point, the output signal LPFO of the low pass filter 240 in FIG. 2 is not output as the output signal SCO of the selecting circuit, and the output terminal T1 of the low pass filter 240 in FIG. 2 is connected to the ground via the resistor R1.

[0032] Even though the first enable signal EN1 is inevitably in a “high” state, as long as the second enable signal is in a “low” state, the NPN transistor Q1 is not turned on. Hence, the up-stream signal of the cable modem is not really loaded on the HFC network via the tuner. However, if the same thing happens to the related art circuit, that is, if the first enable signal EN1 is inevitably in a “high” state (this corresponds to an abnormal operation), an up-stream signal of the

1 cable modem is loaded on the HFC network via the tuner, and as a result, the entire HFC network
2 could be fatally influenced. In addition, if the first and second enable signals EN1 and EN2 are in
3 a “low” state, the NPN transistor Q1 might be turned on, but an internal switch of the PGC 220
4 remains to be off. Therefore, an up-stream signal of the cable modem does not flow in the HFC
5 network via the tuner.

6 **[0033]** Because input/output impedance of a coaxial system is normally $75\ \Omega$ (ohms), the
7 resistance of $75\ \Omega$ is used for the resistor R1, for sake of impedance matching.

8 **[0034]** As discussed before, when the cable modem operates normally, the enable signals EN1 and
9 EN2 are all enabled, and the output signal BCS of the EX-NOR circuit EXNOR1 in FIG. 3 is in a
10 “high” state. Accordingly, the NPN transistor Q1 is turned on. At this time, the relay is turned on,
11 the output terminal T1 of the low pass filter 240 in FIG. 2 is connected to the input terminal T2 of
12 the tuner 250 in FIG. 2, and thus, the output signal LPFO of the low pass filter is transferred to the
13 HFC network via the tuner 250. However, when the cable modem operates abnormally, causing only
14 one of the enable signals EN1 and EN2 to be enabled, the output signal of the EX-NOR circuit
15 EXNOR1 in FIG. 3 is put in a “low” state. As a result, the NPN-type transistor Q1 is turned off.
16 In this case, the relay is turned off, and the output terminal T1 of the low pass filter 240 in FIG. 2
17 is connected to a ground GND via the resistor R1. Also, the input terminal T2 of the tuner 250
18 floats, and the output signal LPFO of the low pass filter is not transferred to the HFC network.

19 **[0035]** The transistor Q1 of figure 4 can also be an NMOS (n-channel Metal-Oxide
20 Semiconductor). As seen in figure 5, an n-channel metal-oxide semiconductor transistor Q1 has a
21 gate terminal (G) to which the output signal (BCS) of the EX-NOR circuit is applied, and a source

terminal (S) connected to a ground GND. The resistor R1 has one end connected to the ground. The relay (RELAY) has a first terminal (term-1) connected to a drain (D) terminal of the n-channel metal-oxide semiconductor transistor Q1, a second terminal (term-2) connected to the resistor R1, a third terminal (term-3) connected to a supply voltage Vcc, a fourth terminal (term-4) to which the modem signal with adjusted intensity is applied (LPFO), and a fifth terminal (term-5) from which the output signal SCO of the switching circuit 262 is output.

[0036] An AND gate can also be used in addition to the exclusive-NOR gate described above. As seen for example in FIG. 6, a two input AND gate (AND1) exhibits an output in a high state only when both inputs EN1 and EN2 are in a high state.

[0037] The present invention can be realized as computer-executable instructions stored in computer-readable media. The computer-readable media includes all possible kinds of recording media in which computer-readable data is stored. The computer-readable media include storing media, such as magnetic storing media (*e.g.*, ROMs, floppy disks, hard disk, and the like), optical reading media (*e.g.*, CD-ROMs (compact disc-read-only memory), DVDs (digital versatile discs), re-writable versions of the optical discs, and the like), system memory (read-only memory, random access memory), flash memory, and carrier waves (*e.g.*, transmission via the Internet). Also, the computer-readable media can store and execute computer-readable codes that are distributed in computers connected via a network.

[0038] In conclusion, the cable modem of the present invention can be advantageously used for preventing an up-stream signal of the cable modem from transferring to the HFC network and for preventing the entire network to be shut down when an internal circuit operates abnormally.

1 **[0039]** While the present invention has been particularly shown and described with reference to
2 exemplary embodiments thereof, it will be understood by those skilled in the art that the foregoing
3 and other changes in form and details may be made therein without departing from the spirit and
4 scope of the present invention.